SECURITY REVERSIBLE KEY AND LOCKING SYSTEM

The invention concerns a security reversible key with an assigned cylinder in accordance with the generic term of claim 1, a locking system with security reversible keys for locking systems in accordance with the generic term of claim 13 and a method for their manufacture in accordance with the generic term of claim 19.Such keys and locking systems are known, where the keys with a high degree of security and a correspondingly high number of possible coding permutations of necessity have at least three -, in preference at least four coding -, resp., tumbler pin rows, which are also located on the flat sides of the key, in order to make the best possible use of the available space, i.e., the given key surface, as well as the corresponding space requirement for the tumbler pin rows in the cylinder. Known are also keys with additional security elements, which once again require a certain amount of space. From US 5 438 857, such a key is known, with an insertion blocking system as an additional security element. Here an additional control face is located on the key, which by means of an assigned control pin at the cylinder entrance prevents the insertion of a wrong key. This control pin is longer than a coding pin and extends beyond the central bisecting plane of the key. The control face is arranged at the tip of the key and rising, it correspondingly also extends beyond the central bisecting plane of the key and lifts the control pin and with this pushes it out of the way. This control pin as a result of this prevents the insertion of keys without a correct control face. These control faces can already be affixed to the key blank and with this enable a protection of the blank.

These known high-security keys and systems with high-security keys are also always limited by the space available for the coding and security functions on the key and in the cylinder. Their manufacture calls for a central production, which limits, renders more difficult and delays the world-wide universal application of such systems. Also an optimum design for installations and applications of any kind is severely restricted by this.

It is now the objective of the invention presented here to create a security reversible key with an assigned cylinder, resp., a locking system with security reversible keys and assigned cylinders, which can be utilized as a world-wide unique locking system, with higher permutation capacities for any kind of application, with enhanced security and copy protection as well as with new possibilities of being in a position to separate any kind of market area and application world-wide and whereby without any additional space requirement on keys and cylinders a higher security and a greater number of permutations is achieved. Sought as a further objective is a manufacturing method for a system of this kind, which can rapidly and universally be brought into use and applied world-wide.

This objective is achieved in accordance with the invention by a security reversible key with an assigned cylinder in accordance with claim 1, by a locking system with security reversible keys with assigned cylinders in accordance with claim 13, as well as by a method for the manufacture of such keys in accordance with claim 19. With the new additional security element "blocking code", which comprises a coded blocking groove and an assigned pair of blocking tumbler pins, without any additional space requirement on the key and in the cylinder, i.e., with the existing coding positions on the key and the existing pin rows and - positions in the cylinder, an additional insertion blocking system as well as a higher number of permutations and applications are achieved. With the division into areas on the key, whereby the

first area with additional security elements defines an unequivocal segmentation into independent market areas, a system is created, which corresponds to the above named objective and which can be realized with the new, multi-step manufacturing process.

The dependent claims concern advantageous further developments of the invention, which make possible further advantages with respect to universal usability, the ability of being rapidly manufactured world-wide, security of a locking system, security against copying, number of permutations and applications.

Especially with the new additional security element "blocking code", which comprises a coded blocking groove and an assigned pair of blocking tumbler pins, without any additional space requirement on the key and in the cylinder, i.e., with the existing coding positions on the key and the existing pin rows and - positions in the cylinder, an additional insertion blocking system as well as a higher number of permutations and applications are achieved.

In the following, the invention is explained in more detail on the basis of examples of embodiments and Figures. These illustrate

Fig. 1a	Coding rows with coding positions for two bore patterns on one key,
Fig. 1b	on a key a division into areas, with a first area with additional security elements,
Fig. 1c	a further example of a division into areas,
Fig. 1d	a segmentation of market areas and distributor areas on a key,
Fig. 1e	a connection between division into areas and segmentation of market areas,

Fig. 2 the principle of the blocking code with blocking groove and blocking tumbler pin pair,

Fig. 3 examples of coding steps and blocking steps,

Fig. 4 examples of different tumbler pin shapes,

Fig. 5 blocking groove shapes corresponding to Fig. 4,

Fig. 6 coding shapes corresponding to Fig. 4,

Fig. 7 a blocking groove extending over four positions with differing sectors,

Fig. 8 in three-dimensional representation a blocking groove with a blocking tumbler pin pair,

Fig. 9 in three-dimensional representation different examples of blocking grooves with coding positions (corresponding to the example of Fig. 14),

Fig. 10 a security element „insertion block„ by means of a control face and a control pin,

Fig. 11 a security element „flat pin„ for the flank control of codings,

Fig. 12 a key with four rows of tumbler pins and with blocking pins in the cylinder,

Fig. 13 examples of keys with five and with eight coding -, resp., tumbler pin rows,

Fig. 14 a schematic locking function diagram with two bore patterns and two market areas,

Fig. 15 a schematic locking function diagram with two positions and four market areas,

Fig. 16 a schematic locking function diagram with two positions and one market area,

Fig. 17 a schematic locking function diagram with one position each in two tumbler pin rows and with three market areas.

Fig. 18 an organization diagram of a locking system with segmented market areas and applications,

Fig. 19 a schematic manufacturing diagram for keys of a locking system in accordance with the invention.

Fig. 1a as an example illustrates a safety turning-key S with four pin rows A1 to A4 and with 22 coding positions Pi, each one for a bore pattern left (L) and a bore pattern right (R). The coding row A2 on the key S here has the positions R1 to R5 for the bore pattern R and the positions L6 to L11 for he bore pattern L. On the keys, all positions of both bore patterns can be coded, i.e., there are keys with bore pattern left, keys with bore pattern right and also keys with the two bore patterns R + L. In the assigned cylinder Z, however, for reasons of space for the pins only every second position and with this only either a bore pattern R or a bore pattern L can be equipped with tumbler pins (in the same area). The first coding position P1 (= L11) on the tip of the key here corresponds to the rearmost tumbler pin position P1 in the cylinder with respect to the direction of insertion of the key x.

Fig. 1b illustrates the locking system in accordance with the invention on a key S, whereby on the key at least two areas are defined, with a first area G1, in which at least two additional security elements with a higher degree of difficulty to manufacture are foreseen, and with a second area G2, in which a simple basic coding Cod1 is foreseen, whereby with the first area G1 an unequivocal segmentation into independent market areas Mi = M1, M2, etc. is defined. Also illustrated here are additional security elements, which in the following are more accurately defined: a blocking code BC, a second coding Cod2, preferably with a narrow milling, an insertion blocking system by means of a control face and control pin KF/KS and a flank control of Cod2 by means of a flat pin 23. The simple basic coding Cod1 is, e.g., a coding by means of bores, which is relatively easily implementable anywhere decentralized.

Fig. 1c depicts a different division into areas, whereby the area G1 can be divided into several part areas G1.1, G1.2, etc. Depending on the application and on the desired system design, the area G1, e.g., can also encompass a whole coding row A1. In doing so, also all security elements are affixed in this one coding row. In a different advantageous variant, e.g., also parts of areas with positions at the very front of the key of two coding rows (A1, A2) can form the area G1, whereby, e.g., both parts of areas G1.1, G1.2 can each respectively have a blocking code BC.

Fig. 1d illustrates the division into several independent market areas Mi = M1, M2, etc., as well as the possible further sub-division of each market area into parts of market areas MMi, e.g., into independent distributor areas or fields of application for installations and objects, etc. The market areas Mi are defined with the area G1. The parts of areas MMi can be defined with parts of the area G1 or also with parts of the area G2 or they can equally encompass parts of the areas G1 and G2.

Fig. 1e illustrates, for example, a connection between the areas G1, G2 on the key and the unequivocal separation in the market area Mi, parts of market areas MMi as well as the further subdivisions for objects MMi.i. This is further explained in the description of Figure 18.

Advantageously the area G1 contains at least three security elements Vi. Particularly important and advantageous is the new additional security element „Blocking Code". In the case of the blocking code BC, as an additional coding - and security function in accordance with the invention explained in Fig. 2, the coding position P1 and its function on the key S and in the cylinder Z are maintained.

Fig. 2 schematically illustrates the method of operation of the blocking code BC in accordance with the invention on a key S and in an assigned cylinder Z. The directions in space are in the following designated with x, y, z and x is the key -, resp., the cylinder axis. Located on -, resp., milled into the key is a blocking groove BN, which runs parallel to the key axis x and which extends at least up to the first coding position P1. In the assigned cylinder, correspondingly at least at the rearmost coding position P1 a pair of blocking pins with a spring loaded blocking tumbler pin BZ and with an extended blocking counter pin BG is foreseen. The blocking groove has a coded blocking depth B1, B2, B3 and in correspondence with this the length lb of the pair of blocking tumbler pins (BZ + BG) is coded in such a manner, that lb corresponds to the distance db of the blocking groove BN from the cylinder housing 10, i.e., that the pair of blocking tumbler pins (or pair of blocking pins) fits in the blocking groove with little play. When inserting the key, the following sequence results (a - b - c): The blocking tumbler pin BZ is lifted at a bevelled lead-in face 6 of the key up to the level of the blocking groove BN and with little play with the cylinder housing 10 passes through the blocking groove up to the corresponding coding position P1, whereby the blocking tumbler pin BZ is lowered into this first coding position with a certain coding step, here, e.g., C2. In this position P1 the pair of blocking tumbler pins BZ, BG operates as normal coding position with respect to turning of the cylinder, which in case of a correct coding has to release the shear line 9. If the blocking groove BN is not deep enough, resp., if it has a wrong coding Bi, then the blocking counter pin BG impinges on the cylinder housing 10 and the further insertion of the key is blocked at the bevelled lead-in face (if lb is larger than db, refer to Fig. 8a). The blocking code therefore results in an additional security function, in that the complete insertion can be prevented with additional coding steps (Bi) of the blocking groove, whereby the coding function up until now at the position P1 is maintained. Over and above this, neither on the key, i.e., on the key positions, nor in the cylinder an additional space for the blocking code is required. In the

cylinder simply an up until now normal coding tumbler pin is replaced by the special blocking tumbler pin.

Fig. 3 illustrates possible blocking steps Bi with a depth tb in comparison with the coding steps Ci with the coding depths tc relative to the key surface. In the following examples, here coding steps C1 to C4 (e.g., steps of 0.35 mm) as well as three blocking steps B1, B2, B3 with blocking depths of, e.g., 1.05, 0.55 and 0 mm are utilized, whereby a blocking step B3 with a depth of 0 mm cannot exert a blocking function anymore. The blocking depths Bi can also correspond to the coding depths Ci, therefore, e.g., C1 to C4 and B1 to B4. In a further example, five coding steps C1 to C5 are represented in combination with four blocking steps B1 to B4, e.g., with step distances of 0.3 mm of the Ci and of 0.4 mm of the Bi. In accordance with the combination rule for the blocking steps Bi with the coding steps Ci, the coding depth tc of the coding steps Ci must not be smaller than the blocking depth tb of the preceding blocking groove Bi. In this example, therefore the blocking step B3 can be combined with the subsequent coding steps C3, C2 or C1.

The Figs. 4, 5 and 6 illustrate various possible tumbler pin shapes (Figs. 4a, b, c), assigned forms of the blocking grooves BN (Figs. 5a, b, c) as well as the coding shapes assigned to the tumbler pins (Figs. 6a, b, c). Fig. 4a illustrates a conventional conical tumbler pin shape 21, e.g. for a basic coding Cod1, which can be manufactured by means of simple bores (Fig. 6a). Fig. 4b depicts a narrow, cylindrical tumbler pin shape 22 with correspondingly narrow coding grooves (Fig. 6b), the manufacturing of which, e.g., calls for a difficult to copy, elaborate milling process and which, e.g., can be utilized as a second coding Cod2. Fig. 4c illustrates a flat pin 23, which, e.g., can be utilized for the flank control of a narrow milled coding (Fig. 6b), as will be explained in more detail later on. Further tumbler pin shapes are possible and known, which in principle are a combination of cylindrical

and conical sections. The blocking groove shapes and the coding shapes can be implemented differently and as a result make any copying more difficult and also have the effect of additionally obscuring the coding shapes.

The Figs. 7a, b, c illustrate an example of a blocking groove, which extends over the four most forward coding positions Pi = L11, R5, L10 and R4 of two bore patterns R, L and which correspondingly have several differently coded sectors BN1 to BN4. In doing so, as a rule attention must be paid, that the depth tb of the blocking grooves remains the same from one position to the next position or else becomes smaller (i.e., cannot become bigger) and that equally the width bb of the blocking grooves remains the same from one position to the next one or else becomes smaller. This in conjunction with three blocking steps B1 to B3 and with two blocking groove widths bb1 and bb2 results in the illustrated blocking steps Bi, bbi of the four blocking groove sectors BN1 to BN4.

Fig. 8 illustrates the function of the blocking code in a three-dimensional depiction and Fig. 9 blocking groove shapes and the adjacent coding indentations, which correspond to the example of Fig. 14. In Figs. 8a, b a key S1a is illustrated, with a blocking groove, which has a blocking step B2 and with adjacent coding positions L11 and R5, which have the codings C1 and C2 (corresponding to the key S1a of Fig. 14).

Fig. 8a illustrates a pair of blocking tumbler pins BZ, BG with blocking code B1, the length lb of which is greater than the distance db of the blocking groove from the cylinder housing 10. With this, the complete insertion of the key S1a into this cylinder is blocked. Fig. 8b in contrast illustrates a pair of blocking tumbler pins BZ, BG with a blocking code B2, which corresponds to the blocking code B2 of the

blocking groove BN and which therefore can be completely inserted. This in the schematic diagram of Fig. 14 corresponds to the key S1a, which opens the cylinder Z1 (with coding C1 at the position R5).

The Figs. 9a to 9d illustrate the keys S1, S2, S3 and S1a with differently coded blocking grooves and positions L11 and R5. This also corresponds to the schematic locking function diagram of Fig. 14, which indicates, which key - cylinder combinations open and which ones block.

Fig. 10 as possible additional security element illustrates an as such known insertion blocking system by means of a control face KF at the tip of the key and an assigned control pin KS in the cylinder. This control face KF extends beyond the central bisecting plane 5 of the key, the same as the control pin KS, which impinges on the rising control face KF and has to be pushed out of the way by it in order for the key to be able to be inserted. A key without the right control face, resp., with only normal lead-in faces 6, with its tip encounters this control pin KS, so that the latter prevents the insertion of the key. This is a completely different arrangement and action than according to the blocking code in accordance with the invention, which does not require any special control faces, but works rather more with any existing key lead-in face 6. Advantageously, however, the new blocking code with the blocking tumbler pins BZ can be combined with this known insertion block by means of control faces KF and control pin KS and in particular even be assigned in the same tumbler pin row (e.g., A2), whereby the control pin KS is positioned anywhere in front of the pair of blocking tumbler pins BZ, BG in the cylinder.

A further important additional security element, which can also be assigned in the same tumbler pin row, is illustrated in Figs. 11a, 11b. These illustrate a flank control

at a narrow coding milling Cod2, which is implemented by a flat tumbler pin 23. The flat tumbler pin 23 (refer to, e.g., Fig. 4c) has a diameter d2, which is greater than the width d1 of the coding milling, so that the flat tumbler pin lies on the key surface 7, as is depicted in Fig. 11a. In contrast, in the case of a basic coding Cod1, e.g., in accordance with Fig. 6a, with necessarily wide bores d3 the flat tumbler pin 23 will sink into these indentations in accordance with Fig. 11b, whereby the shear line 9 of the cylinder is blocked. With this, e.g., a simple forged bore instead of the authorized, much more elaborate narrow coding milling Cod2 can be detected and the functioning of a key forged in this manner be prevented.

Advantageously therefore in a tight space and in a single tumbler pin row the following very effective security elements can be combined: in addition to the blocking code BC in accordance with the invention, a second coding Cod2 with a narrow milling, an insertion control by means of control pin KS and control face KF as well as a flank control of the narrow coding Cod2 by means of a flat tumbler pin 23.

Fig. 12 illustrates a cross section through a safety turning-key with four rows of tumbler pins A1 to A4 in a cylinder in accordance with the example of Fig. 1. The row A1 here is implemented with a narrow coding milling Cod2 and with a pair of blocking tumbler pins BZ, BG. The rows A3 and A4 (and optionally also the row A2) here are implemented with a more simple basic coding Cod1. Important is to exploit the given key surface and the space inside the cylinder in the best possible way for coding positions and security elements. To achieve this, of necessity (at least two) rows of tumbler pins also have to be located on the flat sides of the key.

In the case of somewhat bigger keys, it is also possible to foresee more than four rows of tumbler pins.

Fig. 13a for this purpose illustrates an example with five rows of tumbler pins A1 to A5 and Fig. 13b an example with eight rows of tumbler pins A1 to A8, which, however, can only be equipped with tumbler pins in the cylinder to such an extent as space is available. Thanks to the utilization of narrow codings, however, it is also possible to code all eight rows on the key here. This results in a great number of possible permutations as well as in further security reserves. In principle, here too at the beginning of every row of tumbler pins Ai a blocking coding can be foreseen.

In the Figs. 14 to 17, schematic locking function diagrams with different combinations of blocking codes Bi and codings Ci of the adjacent positions Pi are illustrated. In the left-hand column, the codings Bi, Ci of the keys Si are indicated and in the row on top the codings of the cylinders Zi. The keys can have the bore patterns R or L, or R + L (both), while the cylinders can only contain one bore pattern R or L. The schematic diagram indicates with an "X", whether a combination key / cylinder fits, i.e., whether the key opens the corresponding cylinder. All other combinations block. The Figs. 14 to 17 illustrate, how with few blocking codings Bi and adjacent position codings Ci different market areas Mi can be unequivocally differentiated between and how within a market area several derivations, i.e., hierarchic differentiations, of keys can be implemented within an installation.

The schematic diagram of Fig. 14 (which corresponds to the Figs. 8 and 9) illustrates codings Ci with two bore patterns and with two positions

P1 = L11 and P2 = R5

with 5 equipping alternatives with blocking steps Bi = B1, B2, B3 of the blocking grooves and coding steps Ci = C1 and C2.

Defined with this are two independent market areas M1, M2

With three, resp., two derivations.

The key S3, e.g., opens the cylinders Z1 and Z3.

Fig. 15 illustrates only one bore pattern L with blocking code over two positions
P1 = L11 and P2 = L10
with blocking steps B1, B2, B3
and with coding steps C1, C2.
Defined with this are four independent market areas M1 to M4
Each with three derivations.
The key S11abc opens, e.g., the cylinders Z11a, Z11b, Z11c.

Fig. 16 illustrates a bore pattern L with two positions
P1 = L11 and P2 = L10
with blocking code B1, B2, B3
and coding steps L11 = C1 and L10 = C1,
whereby with the blocking steps within a market area five derivations are created.
I.e., key S11abcde opens the five cylinders Z11a to Z11e
and the key S11a only opens the cylinder Z11a.

Fig. 17 illustrates an example with only one position P1 each, however, in two rows of tumbler pins A1, A2. Both positions P1 are coded with C1,
while with the blocking steps B1, B2, B3 of the blocking grooves three independent market areas M1, M2 and M3 are defined.
The key S1 only opens the cylinder Z1, S2 only opens Z2 and S3 only opens Z3.

Fig. 18 illustrates an organization of the locking system in accordance with the invention with security reversible keys in a hierarchic schematic diagram. The

system owner SS (e.g., a manufacturing company) represents the highest hierarchic level, which defines and authorizes the market areas Mi = M1, M2, etc., whereby a market area, e.g., can be a country or a general distributor. In the market areas, further parts of areas Mmi are defined and separated, e.g., for different distributors or installations within this area. A further level Mmi.i, e.g., can define individual objects. This is defined by the codings of the areas G1 and G2.

Fig. 19 schematically illustrates a manufacturing method for keys of a system in accordance with the invention with manufacturing steps H, areas G on the key and with the manufactured variables Vi in the areas G. On principle the manufacturing H with reducing degree of difficulty HS takes place on lower levels, respectively, decentralized.

The variables Vi and security elements manufactured in the various areas Gi and in the corresponding manufacturing steps Hi, for example, are also indicated in the table.

With the manufacturing of keys and cylinders of a locking system with at least two areas G1, G2 on the keys, first the first area on the keys is manufactured, resp., controlled and authorized at a central place of manufacture H1 and the coding Cod1 of the keys of the second area G2 and the equipping of the cylinders with corresponding pins can subsequently take place at a local representative: H2.

The manufacturing can take place in at least two steps, resp., in different places, whereby first variables with a higher degree of difficulty HS of the area G1 are manufactured in a central location and subsequently variables with a lower degree of difficulty of the area G2 are manufactured decentralized or locally.

The manufacturing of the keys can also take place in three steps, whereby first the first area G1 with variables Vi of the highest degree of difficulty is manufactured centrally : H1; thereupon a further area G1/2 with variables with a lower degree of

difficulty is manufactured regionally : H1/2 and finally the coding G2 with the lowest degree of difficulty of the area G2 is manufactured locally at the place of use : H2.

In a further development of the system, the manufacturing of the area G1 can also take place decentralized. To implement this, manufacturing programs and the authorization „aut" can be controlled and checked from the central location SS (system owner).

With the system in accordance with the invention and the manufacturing methods a universal differentiation of market areas and parts of market areas as well as a rapid local manufacturing are made possible.

Within the framework of this description, the following designations are used:

x, y, z	Directions in space
x	Key axis
S, Si	Key
Z, Zi	Cylinder
Pi	Coding positions
R, L	Right-hand -, left-hand bore pattern
Ri, Li	Right-hand -, left-hand coding positions
Ai	Coding rows, pin rows
Bi	Coded blocking steps
Ci	Coding steps
BC	Blocking code
BN	Blocking groove
BZ	Blocking tumbler pin
BG	Blocking counter pin
BZ + BG	Pair of blocking tumbler pins, pair of blocking pins
lb	Length of BZ + BG

db	Distance from BN to 10
tb	Depth of BN
bb	Width of BN
tc	Depth of the coding steps Ci
d1, d2, d3	Diameters
Cod1	Basic coding
Cod2	Second (different) coding
KF	Control face
KS	Control pin
Mi	Market areas
MMi	Parts of market areas
SS	System owner
aut	Authorization
H1, H2	Manufacturing steps
HS	Degree of manufacturing difficulty
G1, G2	Areas on S
Vi	Variables, security elements
5	Central bisecting plane of S
6	Bevelled tip of S, lead-in face of S
7	Surface of S
9	Shear line in Z
10	Cylinder housing
11, 12	Supporting surfaces at tumbler pins
15	Bevelled face at tumbler pins
21 - 23	Various shapes of tumbler pins
23	Flat pin